Specification

Title of the Invention

HIGH PRESSURE DISCHARGE LAMP ARC TUBE AND METHOD OF PRODUCING ~~THE SAME,~~

Field of the Invention

The present invention relates to a discharge vessel or chamber for a high-intensity discharge lamp and particularly, to a discharge vessel or chamber having a capillary at each end thereof for holding en electrode and a method of fabricating the same.

Background of the Invention

Ceramic made discharge vessel or chambers for high-intensity discharge lamps are generally classified into an integral type where the center body defining a discharge space and the capillary for holding an electrode are formed integral with each other and an assembly type which comprise the body and the capillary fabricated separately as two different components and assembled together. In either type, as shown in the explanatory cross sectional view of Fig. 6, an electrode is fabricated by an electrode material 12 with a discharge electrode 14 made of tungsten or the like joining to the distal end of a current

conductor 13 made of niobium, molybdenum, or the like and inserted into capillary 11 made of an alumina based ceramic material or an alumina material before the gap between the electrode and the capillary is sealed air-tightly with a frit sealer 15 of a glass material.

The discharge vessel or chamber is then baked at its body and capillary simultaneously at a proper temperature.

As the discharge vessel or chamber of such a conventional capillary type is baked at a high temperature for increasing the permeability of light across its body, it will be declined in the physical strength. In particular, when the capillary is joined and sealed with the electrode, it may possibly crack. It is hence essential for prevention of any crack to control the frit sealer to a precise amount and increase the thickness or physical strength of the capillary.

However, the controlling of the amount of the frit sealer requires a highly precision technique while the increasing of the thickness of the capillary interrupts the down-sizing of a resultant discharge lamp.

It is thus an object of the present invention, in view of the above aspects, to provide a discharge vessel or chamber for a high-intensity discharge lamp capable of inhibiting the generation of any crack without controlling the frit sealer to a precise amount or increasing the thickness of

the capillary and a method of fabricating the same.

Summary of the Invention

We, the inventors, have studied on the sintering characteristic of a ceramic where the higher the sintering temperature, the greater the diameter of grains in the ceramic becomes thus decreasing the physical strength or the lower the sintering temperature, the smaller the diameter of grains in the ceramic becomes thus increasing the physical strength. As a result, an improved discharge vessel or chamber of a capillary type is developed which is minimized in the generation of cracks. As defined in claim 1 of the present invention, a discharge vessel or chamber for a high-intensity discharge lamp having a center body arranged providing a discharge space therein and two capillaries provided for shutting up both end openings of the body and accepting a pair of electrodes respectively is provided wherein the center body and the capillaries are made of an alumina material or an alumina-based ceramic material and the average diameter of alumina grains in the capillaries ranges from 10 micrometers to 25 micrometers.

As defined in claim 2 of the present invention, the discharge vessel or chamber according to claim 1 may be modified in which the capillaries contain an amount of

magnesium oxide, yttrium oxide, zirconium oxide, scandium oxide, lanthanum oxide, or their combination, 1.5 times greater than that of the center body.

As defined in claim 3 of the present invention, the discharge vessel or chamber according to claim 1 may be modified in which the center body and the capillaries are made of an alumina-based composition.

As defined in claim 4 of the present invention, a method of fabricating a discharge vessel or chamber for a which has a center body arranged providing a discharge space therein and two capillaries provided for shutting up both end openings of the body and accepting a pair of electrodes respectively is provided comprising the steps of: forming the center body and the capillaries from an alumina material or an alumina-based ceramic material; and sintering the center body and at least portions of the capillaries at different temperatures.

Brief Description of the Drawings

Fig. 1 is an explanatory cross sectional view of an electrode section of a discharge vessel or chamber for a high-intensity discharge lamp showing a first embodiment of the present invention;

Fig. 2 is a diagram showing the relation between the dosage of magnesium oxide, the average grain diameter, and

the physical strength;

Fig. 3 is a flowchart showing a procedure of fabricating the discharge vessel or chamber shown in Fig. 1;

Fig. 4 is an explanatory cross sectional view of an electrode section showing a second embodiment of the present invention;

Fig. 5 is an explanatory cross sectional view of an electrode section showing a third embodiment of the present invention; and

Fig. 6 is an explanatory cross sectional view of an electrode section of a conventional discharge vessel or chamber for a high-intensity discharge lamp.

Description of the Numerals or Symbols

1...Discharge vessel or chamber, 2...Center body, 2a...Opening. 2b...Discharge space, 3...Capillary, 5...Center body, 6...Plug, 7...Capillary, 8...Tubular member, 9...Center body, 10...Capillary, 10a...Cover portion, 10b...Capillary portion

Best Modes for embodying the Invention

Some modes for embodying the present invention will be described in more detail referring to the relevant drawings. Fig. 1 is an explanatory cross sectional view of a electrode section of a discharge vessel or chamber of a high-pressure discharge lamp according to the present

invention. The discharge vessel or chamber 1 comprises a center body 2 having an opening 2a provided at each end thereof and a discharge space 2b defined therein and a pair of capillaries 3, each inserted into the opening 2a and having a tubular shape for accepting and holding an electrode material (not shown). The capillary 3 is doped with an amount of magnesium oxide substantially 20 times greater than that in the body 2 and its average diameter of alumina grains is decreased to as smaller as 19 micrometers than 32 micrometers in the body 2 for increasing the physical strength.

The doping of magnesium oxide permits the average diameter to be decreased, thus improving the physical strength. Accordingly, the generation of cracks during the installation of the electrode material will be prevented. It is hence unnecessary for the sealing to measure a precise amount of the frit sealer and fill the gap close to the center body with the frit sealer more than hitherto. It is also not needed to increase the thickness of the capillary, thus down-sizing the discharge lamp with much ease.

The dosage of magnesium oxide is not limited to 20 times greater than in the center body but may be within a range of the ratio shown in the diagram of Fig. 2 for the relation between the dosage, the average grain diameter, and the

physical strength. At the ratio where the capillary 3 is greater in the dosage of magnesium oxide than the center body 2, it can be smaller in the average diameter but higher in the physical strength than the center body 2. If the ratio is not greater than 1.5 times, the physical strength may hardly increase. When the ratio exceeds 25 times, the strength is not increased in proportion with the dosage. Hence, the dosage is preferably within a range from 1.5 times to 25 times. In Fig. 2, the horizontal axis represents the ratio in the dosage of magnesium oxide of the capillary 3 to the center body while the bend strength is a ratio to the center body.

A method of fabricating the discharge vessel or chamber will now be descried referring to the flowchart of procedure shown in Fig. 3. The center body 2 and the capillary 3 are made of an alumina material or an alumina-based ceramic material. The procedure starts with forming the capillary 3 at Step 1 (S1). During this forming step, an amount of magnesium oxide, e.g. 20 time greater than of the center body 2, is doped. At S2, a green form is pre-baked at 1200 ℃ for three hours under the atmospheric conditions. The pre-sintering is followed by inserting at S3 the capillary 3 into the opening 2a of the center body 2 formed separately. Then, the assembly is pre-based at 1200 ℃ for three hours

under the atmospheric conditions at S4. Finally, the same is baked at 1850 ℃ for three hours under the hydrogen atmosphere at S5.

The oxide dopant is not limited to magnesium oxide but may be selected from yttrium oxide, zirconium oxide, scandium oxide, lanthanum oxide, and their combination. Those like magnesium oxide also permit the diameter of grains to be minimized and the physical strength to be increased. The center body 2 and the capillary 3 may not be made of the same composition. Preferably, the capillary 3 may contain a metal material, which is used in the joint of an electrode material, in order to make its characteristic of thermal expansion equal to that of the metal material.

Fig. 4 is an explanatory cross sectional view of an electrode section showing the second embodiment of the present invention. A center body 9 has an opening 9a provided at each of both, left and right, ends of a discharge space 9b thereof. Each the opening 9a of the body 9 is shut up with a capillary 10 in which an electrode material (not shown) is inserted and secured by sealing. The capillary 10 comprises a cover portion 10a for closing the opening 9a of the body 9 and a capillary portion 10b extending outwardly and vertically from the center of the cover portion 10a.

A method of fabricating the second embodiment comprises

the steps of forming the center body 9 and the capillary 10 of an alumina material or an alumina-based ceramic material and after pre-sintering, sintering the center body 9 at 1850 ℃. The capillary 10 after formed is pre-baked at 1200 ℃ to 1400 ℃. Then, both are joined to each other and baked at 1700 ℃. The joining is made by the cover portion 10a inserted into the opening 9a and shrunk-on joining to the center body 9.

As the sintering temperature of the center body 9 is 1850 ℃ and that of the capillary 10 is 1700 ℃, i.e. the center body 9 is baked at the higher temperature, the average diameter of alumina grains in the center body 9 can be increased as great as 35 micrometers, hence increasing the permeability of light and improving the optical properties. On the other hand, the capillary 10 is baked at the lower temperature and its average diameter of alumina grains can be as small as 25 micrometers. Using the sintering temperature of 1850 ℃, the physical strength can be increased, for instance, from 29 kg/cm^2 to 38 to 45 kg/cm^2. This will prevent the generation of cracks on the frit sealer during the sealing of the electrode. If the capillary 10 has an average diameter greater than 25 micrometers, its physical strength may be declined. When lower than 10 micrometers,

the other properties including the resistance to corrosion may be degraded. Preferably, the average diameter ranges from 10 to 25 micrometers.

Fig. 5 illustrates a third embodiment of the present invention. A center body 5 of a cylindrical shape has two openings provided in both ends thereof, each the opening shut up with a ring-like plug 6. A capillary 7 is inserted into the center hole of the opening. A tubular member 8 is fitted onto the capillary 7, thus forming a double-capillary structure.

The body 5, the plug 6, and the capillary 7 are assembled and joined by a conventional sintering method, such as a shrunk-on method of sintering at 1850 ℃, which is based on a difference in the shrinkage. After the sintering step, the tubular member 8 is fitted onto the capillary 7 and subjected to a re-sintering process. For example, the tubular member 8 is baked at 1200 ℃, fitted onto the capillary 7, and baked again at 1700 ℃ for shrunk-on joining with the capillary 7.

This can increase the physical strength of the capillary, hence permitting a conventional arrangement of the discharge lamp to be increased in the physical strength and preventing the generation of cracks.

Applicability to Industries

As set forth above, the present invention according to claims 1 to 3 allows the capillary to be improved in the physical strength thus minimizing the generation of cracks during the sealing of the discharge vessel or chamber and also contributing to the down-sizing of the discharge vessel or chamber.

The present invention according to claim 4 allows the center body and the capillary to be different in the sintering temperature so that the average diameter of grains in the capillary can be smaller than that in the center body. As a result, the physical strength of the capillary can be increased thus preventing the generation of cracks during the sealing with the electrode.